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COMMITTEE ON THE PEACEFUL USES
OF OUTER SPACE

REPORT ON THE SECOND UNITED NATIONS INTERNATIONAL TRAINING COURSE ON REMOTE-SENSING EDUCATION FOR EDUCATORS, HELD IN COOPERATION WITH THE GOVERNMENT OF SWEDEN

(Stockholm and Kiruna, Sweden, 11 May-12 June 1992)

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INTRODUCTION

A. Background and objective

1. At its thirty-seventh session, the General Assembly adopted resolution 37/90 of 10 December 1982, in which it endorsed the recommendation of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) that the United Nations Programme on Space Applications should promote the growth of indigenous nuclei and an autonomous technological base in space science and technology in developing countries.

2. At its thirty-fourth session, in June 1991, the Committee on the Peaceful Uses of Outer Space endorsed the activities of the United Nations Programme on Space Applications for 1992 as proposed by the Expert on Space Applications and as recommended by its Scientific and Technical Subcommittee at its twenty-eighth session. Subsequently, the General Assembly, at its forty-sixth session, endorsed the activities of the Programme for 1992 (resolution 46/45 of 9 December 1991).

3. In response to resolution 46/45 and in accordance with the UNISPACE 82 recommendations, the United Nations Programme on Space Applications included, as one of its 1992 activities, the organization of a training course on remote-sensing education for educators. The training course was also organized as part of the contributions of the Government of Sweden to the United Nations participation in the International Space Year - 1992 (ISY), which included the development of indigenous capability in remote-sensing technology through the provision of relevant education for educators.

4. The United Nations International Training Course on Remote Sensing Education for Educators was organized in cooperation with the Government of Sweden through the Swedish Agency for International Technical and Economic Cooperation (BITS) and hosted by Stockholm University and the Swedish Space Corporation (SSC Satellitbild) for the benefit of developing countries. The course was held at Stockholm and Kiruna from 11 May to 12 June 1990.

5. The main objective of the course was to develop the practical knowledge and skills of educators from developing countries in remote-sensing technology as well as to equip them with the ability to introduce elements of the technology, as appropriate, in the education curricula in their universities and institutes.

6. The present report, which covers the background, objective and organization of the training course as well as a summary of the presentations, has been prepared for the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee. Participants in the course will report to the appropriate authorities in their respective countries.

7. The participants expressed their appreciation to the United Nations and the Government of Sweden for organizing and hosting the course, for their financial assistance and for the technical quality of the course.

B. Organization and programme

8. Participating in the course were 27 individuals from Bangladesh, Colombia, Costa Rica, Ecuador, Ethiopia, the Lao People's Democratic Republic, Mexico, Mozambique, Nigeria, Pakistan, Panama, Papua New Guinea, Sri Lanka, Suriname, Swaziland, Thailand, Uganda, the United Republic of Tanzania, Uruguay, Venezuela, Viet Nam and Zambia. A list of the course participants is contained in annex II to the present report.

9. Funds allocated by the United Nations were used to defray the costs of international air travel for five participants. The Government of Sweden provided room and board, local transportation and pocket money for all the participants as well as international travel expenses for 22 participants.

10. The programme of the course was designed jointly by the United Nations, Stockholm University and the Swedish Space Corporation, SSC Satellitbild. The United Nations was responsible for the overall external organizational arrangements, and the Government of Sweden, through Stockholm University, SSC Satellitbild and BITS, coordinated local arrangements and provided technical equipment, materials, course facilities and local transportation. The programme of the course is contained in annex I to the present report.

11. The course was opened by Mr. S. Petersson of BITS, on behalf of the Government of Sweden. The United Nations welcoming statement was presented by Mr. S. Chernikov of the Office for Outer Space Affairs. A closing statement on behalf of Mr. A. A. Abiodun, United Nations Expert on Space Applications, was also presented at the closing ceremony of the course.

12. The presentations at the course focused on problems of the development and use of remote-sensing technology in natural resource management and environmental planning, as well as on the development and introduction of remote-sensing education programmes in participants' countries. Other topics covered during the five-week training course included an overview of remote-sensing applications with emphasis on case studies in which data and satellite imagery of participants' own countries were used; principles of visual and digital image analysis; use of Geographic Information Systems (GIS) in different fields of applications, and remote-sensing education. The participants were also provided with fieldwork experience, practical exercises and training in relevant fields.

13. A number of lecturers and participants presented the projects/programmes in which they were involved. These presentations included case-studies of projects conducted in countries of Africa, South-East Asia and Latin America as well as remote-sensing research and training applications in the developing countries.

14. Numerous practical exercises were organized in order to provide the participants with the opportunity of hands-on training in visual interpretation of remote-sensing data. The course was supplemented by on-site visits to the SSC ground station at Esrange and SSC facilities and laboratories at Satellitbild, Kiruna.

I. SUMMARY OF THE COURSE

A. Remote-sensing satellite systems

1. The Landsat system

15. Data and images from the Landsat system have been available since 1972. The result has been that most areas of the world are now well covered, with several images taken over the same areas at different times of the year. This repeated, or multitemporal, coverage is one of the important advantages of the system as it will permit early detection and monitoring of potential environmental hazards as well as season-dependent changes in farming, natural vegetation, etc.

16. Another characteristic of great importance, compared to conventional aerial photography, is the multispectral capabilities of the sensor systems on board the satellite. Instead of being limited to acquiring images of the scene in the visible and very near infrared region of the electromagnetic (EM) spectrum as with camera and film, the Landsat multispectral system records images from several bands of the visual, near and thermal infrared regions. Analysis of an image obtained in a specific part of the spectrum, or combinations from two or more bands (images), can help to differentiate between terrain features and details, which otherwise would be difficult to separate. The wavelength band intervals for the two Landsat sensor systems, its Multi-Spectral Scanner (MSS) and Thematic Mapper (TM) are indicated in the table below. The spatial resolution of the images obtained by the MSS sensor is 80m, while the resolutiion of the TM sensor is 30m.

Wavebands for Landsat and SPOT detectors
(μm)

	Landsat		SPOT	
Band no.	MSS	TM	SX	P
1	0.5-0.6	0.45-0.52	0.50-0.59	0.51-0.73
2	0.6-0.7	0.52-0.60	0.62-0.68	
3	0.7-0.8	0.63-0.69	0.79-0.89	
4	0.8-1.1	0.76-0.90		
5		1.55-1.75		
6		10.4-12.5		
7		2.08-2.55		

2. The SPOT system

17. The SPOT satellite system is in many aspects similar to the Landsat systems. It has similar multispectral and multitemporal characteristics as well as the potential of large area coverage.

18. A notable difference is SPOT's capability to provide images of the same area obtained from consecutive orbits. While Landsat only gives a flat representation of the land surface directly below the satellite, SPOT can be programmed to view the same area during its next (or previous) three orbits. This allows the construction of a quasi-stereoscopic image which can be utilized for topographic mapping. Recent studies indicate that it is possible to produce topographic ortho-photo maps to the scales of 1:50,000 and larger, with contour intervals of 20m, through direct measurements based on the digital image data.

19. SPOT obtains images of the Earth with a resolution of 20m in its multispectral mode and a 10m resolution in its panchromatic mode. However, the higher resolution of the SPOT system leads to an increase of up to nine times in the number of picture elements to be handled per unit. To be able to handle all these data, the size of the scene has been reduced to approximately one tenth of that of the Landsat MSS scene, or 3,600 km^2. More SPOT images will be required to cover the same area as with Landsat and the cost will be higher.

3. Landsat standard products

20. Overview images, also called "quick-looks" can be ordered as a small-scale paper print from Landsat images to check cloud cover and to identify geographical location. Quick-looks are MSS products but cover the same areas as the simultaneously obtained TM images.

21. Full-resolution images can be ordered as paper of film print in black-and-white or in colour. The spectral bands can be chosen for specific purposes and can be combined in a colour composite. Due to the increased number of pixels in the corresponding TM images, TM photo products are processed only in quarter-images scenes. The most common scale of the MSS film originals is 1:1,000,000, while for TM film products it is 1:500,000 (quarter scene).

22. MSS and TM data in digital form are delivered as full scenes with all spectral bands or a single spectral band. TM data can also be ordered covering only a quarter of the full MSS scene. Data are delivered either in raw form or corrected for radiometrical variations and geometrical distortions.

4. Standard SPOT products

23. Standard SPOT products comprise entire scenes or parts of scenes. A scene corresponds to an area with a length of 60 km and a width of 60-80 km, depending on whether the image is obtained vertically or looking to the side. The scenes are identified on a predetermined grid on the Earth's surface and with latitude and longitude.

24. Standard products can be ordered at three levels of processing:

Level 1A. This is basically raw (unprocessed) data. Information from the detectors has been processed to normalize each spectral band. Coefficients for calibration between bands and absolute values are specified. No geometrical correction is included. The instrument's viewing angle is specified. This level of processing is particularly suitable for basic radiometric studies and stereo projections;

Level 1B. The data have been corrected for systematic errors with regard to radiometry and geometry, and to account for the Earth's rotation and curvature and angle of registration;

Level 2. A geometrically precision-corrected product. In addition to the radiometric correction in 1B, the image has been corrected on the basis of maps or ground-control points and presented in an optional cartographic projection. Processing is done without a digital terrain model. This means that for areas with a relatively low relief and almost vertical view angles, a positional accuracy of 5m can be achieved in the case of panchromatic images and 10m for multispectral images.

5. Special SPOT products

25. In addition to the above standard products, a number of special products are currently available or will be in the near future, including:

- Merged multispectral and panchromatic data
- Scene-shifted image along the satellite track
- Mosaic from two adjacent scenes along the satellite track
- Mosaic from four adjacent scenes
- Quarter-scene film products
- Large format film products
- Stereoscopic pairs
- Digital terrain models extracted from SPOT stereoscopic pairs
- "Level 3" geometric geocoding using ground-control points and digital terrain models to remove local distortions.

B. Visual interpretation of satellite images

26. At the time of the introduction of the Landsat system the expectations for practical applications, particularly in the developing countries, were quite high. The monitoring of environmental changes and inventories of natural resources in areas lacking the conventional monitoring systems of the industrialized world (i.e., ground-based systems, aircraft remote-sensing systems) was one of many important tasks to fulfil in order to cope with increased demands on the land.

27. The rather low resolution of the first image products and the vast amounts of data, however, favoured the development of computer-based data analysis systems. When such systems were first introduced in the developing countries, their use was based on overseas technical and human resources, while the local knowledge and competence concerning the land and its resources were in most cases unused. The many studies to date have been conducted by foreign experts without a concomitant education of the local experts on the principles on which the technology is based. Once the foreign experts left, the training experience acquired had a limited influence on new practical applications and on the development process. There also has been an overestimation of the use of computer-assisted remote sensing, and the lack of applicable results has to some extent led to a disappointment among the local experts.

28. In many cases, visual interpretation of satellite images, with a knowledge of the physical process that led to them, may prove to be a preferable alternative to numerical analyses, especially in developing countries. The involvement of the local expertise as well as the application of the results will be easier to achieve. The introduction of the SPOT satellite system, with a much higher resolution and the possibilities of stereo viewing, will further facilitate this approach.

29. One advantage of visual interpretation is that the same equipment can be used for conventional interpretation and mapping from aerial photographs. All developing countries have such facilities and, more important, competent staff with a good knowledge of the local conditions. By contrast, many of the computer-based studies rely upon foreign equipment and personnel resources.

30. The practical application of the visual interpretation of satellite images has evolved in the developing countries because of their urgent need for rapid access to actual data for assessment of land and water resources. In most cases visual interpretation of Landsat and SPOT imagery has been based either on black-and-white images of the various spectral bands or on false colour composites (FCC). Bitemporal or multitemporal analyses are often made in order to improve the classification of the various landscape elements or monitor the annual or seasonal changes.

C. The use of satellite imagery in land-systems mapping

31. Land system surveys based on satellite imagery in conjunction with field traverses are not as good as those based on photo-interpretation but are not demonstrably very much worse. For example, air-photo interpretation at 1:250,000 of part of the Sudan took 8 man-months per 1,000 km^2, compared with 1.5 man-months per 1,000 km^2 for a survey of a similar area using Landsat imagery in conjunction with partial photo-interpretation. The territory of Ethiopia has been covered by Landsat interpretation at 1:1,000,000 by a small team in one year, a task unthinkable using air photographs.

32. Thus, the value of the results of satellite-based survey may be lower, but not by a large margin - perhaps more or less "half as good" - but the cost of completing such a survey is lower by a factor of 10 or more. Hence the results obtained per unit cost are certainly greater; in addition, they are obtained much more quickly. Given that the usefulness of reconnaissance surveys in development planning is limited, it may prove to be the case that the functions which they do serve can be achieved satisfactorily by satellite-based survey.

33. The initial stage, that of drawing provisional boundaries based on the satellite imagery, does not differ in principle from air-photo interpretation. Patterns of inferred landforms and land cover (vegetation/land use) are identified and delimited. Their provisional description is more inferential and tentative than from stereoscopic viewing of air photos, leaving more detail to be added or modified at the stage of field traversing. A nested procedure combining complete coverage by satellite imagery with conventional photo-interpretation for sample areas is now often the best way of conducting reconnaissance surveys.

34. A land-systems map of the Great Ruaha catchment in the central part of the United Republic of Tanzania was made in 1976. The drainage basin is about 65,000 km^2 in area and the only possible practical way to construct a land-systems map was to use satellite imagery. It was found that the detailed information obtained from the satellite images varied with terrain factors, relief and vegetation. The most detailed geomorphological information could be obtained from open spaces such as grasslands and wooded grasslands, and from high-relief areas such as inselberg plains etc. The least amount of information was obtained from wooded, low-relief areas, where the small-scale geomorphological items (i.e., land facets) could hardly be distinguished from the intensive signals from the vegetation cover.

35. The greatest advantage gained by using satellite images instead of conventional air-photo mosaics for land-systems mapping is that the same colours prevail over large areas, representing the same type of terrain or vegetation. The colours are good indicators of soil types and drainage conditions due to differences in moisture content and vegetation. SPOT satellite images have subsequently been tested for land-systems mapping of the same area, and the stereo option has furthermore enhanced the interpretation of the land systems and the subdivision of the systems into land facets.

D. Erosion hazard assessment

36. Analysis of erosion risk is a procedure aimed at describing the physical danger of soil erosion over large areas. Estimates of erosion hazards normally include the observations of a range of erosion factors, such as rainfall erosivity, soil erodibility and vegetation cover. The assessment methods also consider the variable that best describes each factor's influence on erosion, plot the individual spatial distributions of each variable and then combine them to estimate an overall hazard.

37. In a method developed for the countries of southern Africa, the estimates of the erosion hazards are based strictly on physical data of rainfall erosivity, soil erodibility, vegetation cover/type of land use and topography (with the information from relief data compiled from topographical maps). Erosion hazard maps are being produced in these countries, showing the potential risk areas on a map of each country. The practical applications of this technique are especially evident if one is interested in a rapid assessment of the hazard within smaller project areas or within areas lacking accurate physical data on soils, topography and rainfall. In such cases remote-sensing applications are recommended.

38. In a recent Tanzanian study of the environmental hazards of the Mtera hydroelectric power project, the erosion hazard assessment was based on the interpretation of SPOT satellite imagery in combination with limited field surveys. The SPOT satellite images used for the analyses in the study were stereo transparencies (False Colour Composites, FCC) at a scale of 1:400,000. The interpretation was made in an advanced stereoscope and the plotting of the results was done on transparent film overlays covering enlarged images at a scale of 1:100,000. The drainage net was mapped down to the first-order gullies and the geomorphological units (land systems, land facets) were mapped in relation to their importance as sediment sources, deposition zones and areas of temporary sediment storage.

39. The classification of erosion intensity was based on the South African system developed for use with air-photo interpretation. This system was subsequently modified for use with satellite images. As sheet erosion is that erosion type most easily detected on the satellite scenes, because of exposure of highly reflectable subsoil or sediment deposits on the fields it was natural to concentrate the inventory on this erosion type only. The classification and interpretation was related to a grid of 1 x 1 km squares represented on a transparent overlay. It was possible to retain the original five erosion classes due to the high resolution of SPOT images. Therefore, the soil erosion is described in terms of:

Class 1: None apparent. No visible signs of erosion. Level of management appears to be high;

Class 2: Slight. Areas of erosion (light-blue tone) observed on the images. Erosion deduced from poor cover, sediment deposits and plant pedestals (as observed in the field);

Class 3: Moderate. Eroded areas obvious on the images. Plant cover is very poor and the sediment deposits are extensive. Associated with small rills (as observed in the field);

Class 4: Severe. Sheet erosion of such a severity is always associated with rills and gullies. Much of the A-horizon has been removed;

Class 5: Very severe. As class 4. Erosion type makes up most of the unit area associated with gully erosion class 5.

40. Two new classes were added indicating different accumulation or temporary sediment storage areas. Class I represents sediment storage on colluvial slopes; class II represents floodplain deposition, alluvial fan deposition or braided outwash deposition.

41. Environmental hazards threatening the environment of the reservoir region are related to land-use changes causing vegetation and soil degradation, which result in an increased sediment yield to the reservoir. However, the bulk of the sediment transported into the reservoir is in this case transported by the main rivers. Estimates based on a previous water sampling programme give an annual sediment input to the reservoir of 4×10^6 tonnes.

42. In the SPOT study, maps have been produced of the drainage net (streams and gullies), geomorphological units and sheet erosion intensity (by visual interpretation of SPOT imagery). To estimate the management hazards for the reservoir region, a factor scoring analysis has been carried out based on results of the thematic mapping. The following classes were used for the different areas:

(a) Drainage net:

(1) Areas with closed drainage, drainage to areas upstream from the major sedimentation areas, etc.;

(2) Drainage through channels (gullies) with a direct input to rivers draining directly into the reservoir;

(3) Areas with high drainage density (i.e., gullied land) with direct drainage into the reservoir;

(b) Erosion intensity:

(1) Erosion class 1, deposition classes I and II;

(2) Erosion classes 2 and 3;

(3) Erosion classes 4 and 5;

(c) Environmental hazard score:

0-5: Low

6-8: Moderate

>9: High

E. Environmental impact of river regulation

43. Environmental monitoring and ecological studies of river impoundment can identify and describe a number of actions which should be considered before, during and after construction of a dam. Environmental monitoring of the changes has to be done directly in the field or, for some of the study objectives, indirectly by other methods such as remote sensing.

44. In any river development project it is important to plan for the future both before and during the construction, as well as when a reservoir has been filled to its full level and the commercial operation has started. Planning before the construction includes project documentation made in such a way that future changes can both be predicted and monitored. A monitoring system should furthermore monitor the changes in such a way that the impact during the construction phase could be differentiated from long-term changes.

45. The following factors could be studied:

(a) Geo-ecology of the upstream catchment area. Such studies must include documentation of geomorphology and geomorphological processes (i.e., soil erosion, drainage, slope), climate and hydrology, vegetation and land use, as well as all factors that are important for assessing erosion and environmental hazards;

(b) The reservoir and the reservoir region. Such studies must include studies of the morphology, water level fluctuations, land degradation of the surrounding areas, shoreline development (important for water-related diseases and the human environment), reservoir sedimentation, water quality and aquatic vegetation.

46. It is impossible to tell with certainty what kind of aquatic vegetation will develop in a reservoir. Vegetation development depends on a large number of interacting ecological factors, e.g. pH of the water and mud, dissolved nutrients and oxygen, water temperatures, wind and waves and annual draw-down of the water. However, it is safe to predict that the aquatic vegetation will undergo a number of stages in developing towards some kind of equilibrium. The establishment of "stable" aquatic vegetation will take a long time, and will be influenced mainly by the size of the draw-down for a number of consecutive years, but also by the annual fluctuations in the water level. The two most influential factors are the rainfall and the regulation requirements, both of which are unknown or impossible to predict.

47. An aquatic plant may be called a weed when it starts to cause problems, e.g. with regard to the storage and engineering operations of a reservoir or its multi-purpose use.

48. The rapid or explosive growth of aquatic weeds during the first years of a man-made lake, as experienced in Lake Kariba and Lake Volta, has been linked to a high level of nutrients in the water, originating from flooded decaying organic material submerged in the water.

49. The downstream areas. Items to monitor are related to morphology and sediment transport (i.e., how the changed water regime influences river bank erosion and sediment transport) and in some cases the way in which the reduced sediment transport and changed water regime influences coastal areas, downstream floodplains and water quality.

50. The aquatic environment, or the changed aquatic environment, is important in the development of several diseases in Africa. It is also important in the monitoring of the changes in the environment. For instance, the mosquitoes which breed in water are the transmitters of malaria and filaria-related diseases. The black flies which also breed in water are the transmitters of river blindness.

51. The spread of bilharzia is facilitated by the presence of an aquatic snail which serves as a host for the parasite. More indirectly, the water itself may also influence the occurrence of diseases. For instance, if the vegetation changes due to the presence of water and a thicket vegetation develops, the latter may serve as a suitable habitat for the disease transmitted by the tsetse fly.

II. COURSE EVALUATION

52. At the conclusion of the course, the participants were asked to complete a questionnaire regarding various aspects of the content and organization of the course, including the time allotted to the topics and practical exercises as well as the relevance of the course content to their day-to-day activities. This exercise was followed by a discussion of problems of remote-sensing education in developing countries. During the discussions, the participants made a number of observations on the accomplishments of the course and recommendations for future courses.

53. All participants expressed the opinion that the general organization and the planning of the presentations were of high quality. Depending on their experience and field of expertise, some participants felt that more time should have been spent on topics related to Geographic Information Systems and remote-sensing education. All the participants were of the view that the level and conduct of the course were appropriate for the specific needs of their educational and academic work. The participants expressed their appreciation to the Government of Sweden and to the United Nations for having organized the training course.

Annex I

PROGRAMME OF THE COURSE

I. INTRODUCTION

Date	Time	Subject	Speaker
Monday 11 May	10 a.m.	Introductory lectures:	
		Remote sensing and global change	Prof. Thomas Rosswall
		Remote sensing - current status and future trends of the technology	Prof. Leif Wastenson
	2 p.m.	Management of natural resources and the environment - role of of remote sensing	Mrs. Marie Byström
	2.45 p.m.	Presentation of the Department of Physical Geography	Carl Christiansson Stig Jonsson and Bengt Lundén

II. FUNDAMENTAL PRINCIPLES

Tuesday 12 May	9 a.m.	Electromagnetic radiation, the reflective properties of the Earth and elementary optics	Dr. Johan Kleman
	1 p.m.	Electromagnetic radiation, the reflective properties of the Earth and elementary optics (continued)	Dr. Kleman
Wednesday 13 May	9 a.m.	Electronic imaging	Prof. Quiel
	1 p.m.	Electronic imaging (continued)	Prof. Quiel
Thursday 14 May	9 a.m.	Modern cartography in thematic mapping	Dr. Göran Alm
	1 p.m.	Image geometry and map	Dr. Göran Alm

Date	Time	Subject	Speaker
Friday 15 May	9 a.m.	Image interpretation - theory	Dr. Göran Alm
	1 p.m.	The new generation of environmental satellites - the case of ERS-1	Mr. Jürg Lichtenegger
III. IMAGE INTERPRETATION			
Monday 18 May	9 a.m.	Earth resources and environmental satellites	Prof. Friedrich Quiel
		Lectures on the use of imagery for:	
	1 p.m.	(a) Land-use planning and environmental monitoring	Prof. Friedrich Quiel
	2.30	(b) Geological studies	Prof. Bengt Lundén
Tuesday 19 May	8.30 a.m. to 4.30 p.m.	Case-studies	
Wednesday 20 May	8.30 a.m. to 4.30 p.m.	Case-studies	
		AFRICA	
		Land and water development in Ethiopia	Dr. Rolf Ake Larsson
		Land degradation and soils in Lesotho	Prof. Bengt Lundén
		Land-use mapping in the United Republic of Tanzania	Prof. Lennart Strömquist
		SOUTH-EAST ASIA	
		Environmental impact assessment of hydropower development in the Lao People's Democratic Republic	Prof. Strömquist

Date	Time	Subject	Speaker
		Environmental impact assessment of the closure of a river arm in Bangladesh	Dr. Rolf Ake Larsson
		Land degradation and soils in Lesotho	Prof. Bengt Lundén
		LATIN AMERICA	
		Ecuador	Dr. Rolf Ake Larsson
		Land-use mapping in the United Republic of Tanzania	Prof. Strömquist
		Land degradation and soils in Lesotho	Prof. Bengt Lundén
IV. DIGITAL IMAGE PROCESSING AND ANALYSIS/GIS			
Thursday 21 May	9 a.m.	Digital analysis	Prof. Wolter Arnberg
	1 p.m.	Computer image enhancement	Prof. Arnberg
Friday 22 May	9 a.m.	Geographical Information Systems (GIS theory)	Prof. Friedrich Quiel
	1 p.m.	GIS theory (continued)	Prof. Quiel
Monday 25 May	8.30 a.m.	Computer-aided analysis	Prof. Bengt Lundén
	1 p.m.	Computer-aided analysis (continued)	Prof. Lundén
Tuesday 26 May	8.30 a.m.	GIS exercise	Prof. Lundén
	1 p.m.	GIS exercise (continued)	Prof. Lundén
V. REMOTE-SENSING EDUCATION AND PROJECT MANAGEMENT			
Wednesday 27 May	8.30 a.m.	Project management - theoretical background and role-playing exercise	Ms. Kristina Boman
	1 p.m.	Project management (continued)	Ms. Boman

Date	Time	Subject	Speaker
	2 p.m.	In-service remote-sensing training in the developing countries	Dr. Rolf Ake Larsson
	6 p.m.	Departure from Stockholm harbour. Cruise to Helsinki, Finland .	
Thursday 28 May to Sunday 31 May		Cruise to Helsinki, Finland and back. During the cruise, lectures and work in groups on remote-sensing education case-studies under the direction of Professor Wolter Arnberg take place.	
VI. REMOTE-SENSING APPLICATIONS			
Monday 1 June		Fieldwork exercise. Excursion in the fieldwork area, demonstration of image material, exercises in landscape feature interpretation	Prof. Strömquist
Tuesday 2 June		Fieldwork exercise: image interpretation	Prof. Strömquist
Wednesday 3 June		Presentation of results of the field exercise	Prof. Strömquist
Thursday 4 June		Demonstration of the production facilities at Satellitbild	
		Satillite data processing, image production, satellite image maps	Mr. Torbjörn Westin Mr. Dan Klang Mr. Tommy Lundquist
		Digital map production at the National Land survey, LM-Kartor	Mr. Mats Dahlberg
		Presentation of case-studies from SSC Satellitbild	Mr. Henric Österlund Mr. Lars Björk
		Visit at the Salmijärvi and Esrange receiving stations. Data reception, pre-processing	

Date	Time	Subject	Speaker
Friday 5 June		Practical applications: visual interpretation exercises in groups using imagery in (simulated) projects from the participants' home countries	Mrs. Marie Byström
Saturday 6 June		Practical applications (continued)	Mrs. Byström
Tuesday 9 June		Practical applications (continued). Preparations for the presentation of the results of the visual interpretation project work.	Mrs. Byström
Wednesday 10 June		Presentation of the results of the visual interpretation project work	Mrs. Byström
VII. NEEDS OF THE USER			
Thursday 11 June	9 a.m.	Data acquisition, data correction, image production and costs. How to select the right type of data for a given task	Mr. Alf Erik Öskog, Mr. Jan Unga, Mr. Samuel Forslund, Mr. Per Zeidlitz, Mr. Jörgen Ek, Mr. Anders Persson
	2 p.m.	Trends in remote-sensing contributions to research and applications in the third world. Discussion between participants and teachers	Dr. Stein W. Bie
Friday 12 June	9 a.m. to 12 noon	Course evaluation Closing ceremony	Prof. Wolter Arnberg, Dr. Rolf Bergström, Dr. Rolf Ake Larssen, Prof. Bengt Lundén

Annex II

LIST OF PARTICIPANTS

AFRICA

Mr. Sirak K. Isak
Department of Biology
Addis Ababa University
P.O. Box 1176
ADDIS ABABA Ethiopia

Mr. Virgilio F. Ferrao
National Directorate for
Geography and Cadastre
C.P. 2102
MAPUTO Mozambique

Dr. Taiwo R. Ajayi
Dept. of Geology
Awolowo University
ILE-IFE
Osun State Nigeria

Mr. Ademola S. Omojola
Dept. of Geography and
Planning
University of Lagos
Nigeria

Ms. Miranda Miles
Dept. of Geography
University of Swaziland
P/B 04 KWALUSENI
Swaziland

Mr. Pius Yanda
Institute of Resource
Assessment
University of Dar es Salaam
P.O. Box 35097
DAR ES SALAAM Tanzania

Mr. Nasani Batungi
Makerere University
P.O. Box 16215
KAMPALA Uganda

Mr. Mufalo M. Mbinji
Geography Dept.
University of Zambia
P.O. Box 32379
LUSAKA Zambia

Dr. Daniel S. Tevera
Dept. of Geography
University of Zimbabwe
P.O. Box MP 167
HARARE Zimbabwe

SOUTH-EAST ASIA

Dr. Rahman Mohammad R.
Inst. of Flood Control &
Drainage Research
University of Engineering and
Technology
DHAKA 1000 Bangladesh

Mr. Somsavanh Phanmatha
Hydropower Eng. Consultants
Fangum Rd
P.O. Box 2352
VIENTIANNE Lao PDR

Dr. Azam A. Khwaja
Dept. of Earth Sciences
Quaid-I-Azam University
ISLAMABAD Pakistan

Mr. Jerry Sipuman
Dept. of Surveying and Land
Studies
University of Technology
LAE
The Papua New Guinea

Dr. Amala Jayasekera
Dept. of Agricultural
Engineering
Faculty of Agriculture
University of Peradeniya
PERADENIYA Sri Lanka

Dr. Sunil S. Wickramasuriya
Dept. of Civil Engineering
University of Moratuwa
MORATUWA, Sri Lanka

Dr. Kaew Nualchawee
Asian Inst. of Technology
GPO Box 2754
BANGKOK 10501
Thailand

Mr. Chira Prangkio
Dept. of Geography
Faculty of Social Sciences
Chiangmai University
CHIANGMAI Thailand

Mr. Nguyen Q. Thin
Centre for Remote Sensing
Information Processing
National Centre for Scientific
Research
NAHIA DO-TU
Lien-Hanoi Vietnam

LATIN AMERICA

Dr. Fernando A. Zapata
Dept. de Biologia
Universidad del Valle
Apartado Acro, 25360
CALI Colombia

Mr. Alvaro S. Burgos
Center for Geophysical
Research
Universidad de Costa Rica
SAN JOSE Costa Rica

Mr. Cesar M. Guevara
Centro de Levantamientos
Integrados de Recursos
Naturales por Sensores
Remotos (CLIRSEN)
C.P.18-08-8216
QUITO Ecuador

Dr. Rosa Maria Prol-Ledesma
Inst. de Geofisica
Mexican National University
Universitaria
COYOACAN 04510
Mexico D.P.
Mexico

Mr. Alberto Caballero
Estafeta Universitaria
Apdo. 10761
PANAMA CITY
Republica de Panama

Mr. Lasford E. Douglas
Panama Estafeta University
PANAMA CITY
Republica de Panama

Ms. Renate Tjon-Lim-Sang
Centre for Agricultural
Research
Adek University
Faculty of Technology
P.O. Box 1914
PARAMARIBO Suriname

Ms. Ana Maria Martinez
Dept. of Geography
Universidad de la Republica
Tristan Narvaja 1674
11200 Montevideo
Uruguay

Ms. Carmen L. Goitia Blanco
Instituto de Ingeniera Poba
International in Caracas,
Venezuela
Mailing address:
#438 P.O. Box 02-5255
Miami, Florida